

## Stock-Market Efficiency in Thin-Trading Markets: The Case of the Vietnamese Stock Market

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# Stock-Market Efficiency in Thin-Trading Markets

## The Case of the Vietnamese Stock Market

Short title: Stock-Market Efficiency in Vietnam

Truong Dong Loc, Ger Lanjouw and Robert Lensink\*

### Abstract

*This paper reviews developments in the Stock Trading Centre (STC) in Ho Chi Minh City, Vietnam, the main stock market in the country, since its start in 2000. It presents information about developments in the number of stocks traded, trading activity and stock-price developments. The article focuses on the question whether the market is weak-form efficient. An important element of the investigation concerns the possible bias of the results caused by the thin trading that characterizes the STC. Stock-market returns are corrected for this. The main conclusion is that the STC is not efficient in the weak form.*

**Keywords:** stock-market efficiency, thin-trading stock markets, Vietnam

**JEL-codes:**G14, P34

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## 1. Introduction

A growing number of papers examine whether stock markets in emerging markets behave in line with the efficient-market hypothesis (EMH). Some of these studies reject the hypothesis that the stock markets in question are weak-form efficient<sup>1</sup>. For instance, Wheeler *et al.* (2002) fail to find support for weak-form efficiency in the case of the Warsaw Stock Exchange. Similarly, Grieb and Reyes (1999) reject the hypothesis of market efficiency for all stock- market indexes and most individual stocks in Brazil and Mexico. In addition, Karemera *et al.* (1999) find that stock-return series in Brazil, Chile, and Mexico in general are not weak-form efficient; equally Mookerjee and Yu (1999), Groenewold *et al.* (2003) and Lima and Tabak (2004) document that the stock markets in China are not weak-form efficient, and Abeysekera (2001) and Abraham (2002) reject the hypothesis of weak-form efficiency for stock markets in Sri Lanka, Kuwait, Saudi Arabia and Bahrain.

Other studies, however, provide evidence that stock markets in some emerging market economies are efficient. Dockery and Vergari (1997) document that the Budapest Stock Exchange is efficient in the weak form. In addition, studies by Karemera *et al.* (1999) and Buguk and Brorsen (2003) support the null hypothesis of weak-form market efficiency for the stock market in Turkey. For Africa, Dickinson and Muragu (1994), and Olowe (1999) find that the Nairobi and Nigerian stock exchanges are efficient in the weak form. Seddighi and Nian (2004) document that the Shanghai Stock Exchange is weak-form efficient for the period from Jan. 4, 2000 to Dec. 31, 2000. Fawson *et al.* (1996), Alam *et al.* (1999), and Chang and Ting (2000) support the hypothesis that the Taiwanese stock market is efficient in the weak form. Similarly, the null hypothesis of market efficiency cannot be rejected for the Hong Kong stock market (Karemera *et al.*, 1999; Alam *et al.*, 1999; Cheung and Coutts,

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<sup>1</sup> According to the weak form of the EMH a market is efficient if current prices fully reflect all information contained in past prices (Fama, 1970). It implies that past prices cannot be used as a predictive tool for future stock price movements and hence it is not possible for a trader to make abnormal returns by only using the past history of prices.

2001; and Lima and Tabak, 2004). In addition, it is documented that stock markets in the ASEAN region (Indonesia, Malaysia, Thailand and Singapore) behave in line with the weak form of the EMH (Barnes, 1986; Karemera *et al.*, 1999; Alam *et al.*, 1999). With respect to the Southern part of Asia, Sharma and Kennedy (1977) and Alam *et al.* (1999) provide evidence supporting the hypothesis of market efficiency for the Bombay (India) and Dhaka (Bangladesh) Stock Exchange. Thus, results regarding market efficiency are mixed and country-dependent.

While studies on stock markets in emerging markets are widely available, so far not any study has focused on Vietnam. This is unfortunate, since the Vietnamese stock market, although still characterized by low capitalisation and thin trading, is rapidly developing. The Vietnamese stock market also is an interesting case since Vietnam is one of the world's few remaining communist countries and insight into the functioning of a typically capitalist institution like a stock market within such a country could give new perspectives on the possible co-existence of elements of different ways of organizing economic and political systems. The main Vietnamese stock market, formally known as the Securities Trading Centre (STC), located in Ho Chi Minh City, was launched on July 28, 2000. At the opening trading session only two stocks with a total market capitalisation of VND 444,000 million (about USD 28.20 million) were traded at the market. Over five years of operation (until the end of 2005), the number of listed companies has increased to 32, with a total market capitalisation of VND 6,337,480 million (about USD 402.38 million).

This paper aims to have a closer look at the stock market in Vietnam. We describe, in detail, the organisation of the Vietnamese stock market and its development. We focus on whether the Vietnamese stock market is weak-form efficient. The reason behind this is that if the evidence would fail to support the weak-form of market efficiency, it is not necessary to examine the EMH for the more demanding degrees of the semi-strong and strong form (Wong

and Kwong, 1984). As such testing for weak-form efficiency is a logical first step in investigating market efficiency in a certain stock market. To test for market efficiency we apply autocorrelation tests, runs tests and variance-ratio tests. The data used for these tests consists of observed weekly returns of the market index and five individual stocks listed on the market. A special feature of the analysis is that we correct the data for thin (infrequent) trading, which is a prominent characteristic of the Vietnamese stock market.

The remainder of this paper is organised as follows. Section 2 provides an overall description of the organisation and operation of the Vietnamese stock market. Section 3 summarizes the performance of the market over the period from July 28, 2000 to December 31, 2005. Section 4 describes the data we have used<sup>2</sup>. Section 5 explains the tests that we use for examining the weak form of market efficiency. Section 6 presents the results. Section 7 concludes.

## **2. Organisation and operation of the stock market**

The State Securities Commission (SSN), officially established in November 1996, is responsible for the organisation, development and supervision of the country's securities market. Before February 2004, the SSC had operated as an organ under the direct responsibility of the Prime Minister. However, the Prime Minister decided, on February 19, 2004, to hand over the task of managing the SSC to the Ministry of Finance. The SSC is responsible for four security-trading centres: the Ho Chi Minh City (HCMC) Stock-Trading Centre (STC), the Hanoi Stock Trading Centre, the Securities Information Technology Centre, and the Centre for Securities Research and Training. In this paper we concentrate on the Ho Chi Minh City Stock-Trading Centre, being the main stock market in the country.

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<sup>2</sup> There is a discrepancy between the time span of the data used in the more descriptive Sections 2 and 3, where we like to mention the latest available data, and the later sections of the paper where the formal empirical testing is reported (data period 2000-2004).

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As of December 31, 2005, 13 securities companies (see Table 1) have been licensed, with a total registered capital of VND 605,750 million (USD 38.47 million). Securities companies can be established either as joint-stock or as limited-liability companies. The main business of the securities companies is brokerage, own-account trading<sup>3</sup>, securities investment portfolio management, underwriting, and financial and securities investment advice. In order to receive a license for the securities business the company should have a business plan that is in line with the objectives of Vietnam’s socio-economic development and growth of the securities industry; it should have adequate technical facilities for securities-business activities; it should have a certain minimum level of legal capital, dependent on the type of securities business; it should have a director, vice-director, and practitioners who are qualified for being granted the securities practitioner certificate by the SSC.

A company has to fulfil some qualifications before it can be listed at the Vietnamese stock market. The main requirements are a minimum capital of VND 5 billion (USD 0.32 million) and having been profitable in the last two consecutive years before the year of applying for listing. Furthermore, members of the firm’s Board of Directors, Board of Management, and Board of Supervisors have to hold at least 50 percent of their shares for three years from the date of listing, and there should be at least 50 outside investors, holding 20 percent of the firm’s equity at minimum.

Companies that want to be listed are required to submit certain documents to the SSC, including financial statements approved by accepted auditing organisation, the firm’s charter and a prospectus containing information similar to that required by regulatory bodies in developed countries. Within 45 days from the date of receiving a full and complete set of application documents, the SSC will decide about granting the listing license to the firm.

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<sup>3</sup> Own-account trading is defined as buying and selling activities of securities for the securities companies’ own account.

Before April 15, 2003 foreign companies were not permitted to act as joint-stock companies, so they are ineligible to apply for admission to be listed at the STC. Recently the Ministry of Planning and Investment has conducted a pilot scheme that converts foreign-

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invested companies into joint-stock companies for the purpose of listing. The criteria for listing of foreign-invested joint-stock companies are mostly equivalent to those applicable to domestic joint-stock companies. At the end of 2004 20 foreign-invested companies have applied for conversion into joint-stock companies.

Listed companies are required to disclose all information that is important for investors' investment decisions. The information under this obligation can be classified into two categories: regular and irregular information. Regular information includes quarterly, semi-annual, and annual financial statements. Within 10 days from the date of completing annual financial statements, listed companies have to disclose their audited financial information in three consecutive issues of a national newspaper or a local newspaper at the location of the head office of the company or on the Bulletin of the STC. Quarterly and semi-annual financial statements listed companies have to be disclosed within five days from the date of completion via the Bulletin of the STC. Irregular information consists of any information related to events that happen irregularly and could affect investors' decisions<sup>4</sup>.

All listed securities are required to be traded via the STC in Ho Chi Minh City. All securities listed at the STC should be denominated in Vietnamese Dong (VND) with a standardised par value for each of VND 10,000. For the first period from July 28, 2000 to March 1 2002, trading sessions have been conducted on Monday, Wednesday and Friday, from 8h00 am to 10h00 am. From the beginning of January 2001, the trading sessions were shortened to one hour, from 9h00 am to 10h00 am. From March 1, 2002, the market trades

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<sup>4</sup> The listed companies are required to disclose information within 24 hours if, *e.g.*, a significant change in conditions of its business activities occurs; if it suffers from a loss equivalent to or more than 10 percent of its equity; if there is a change in the firm's business strategy or other important decisions on business activities are taken, such as major investments in other firms or in fixed assets; and if the company falls into bankruptcy, or makes a decision on corporate merger, acquisition, split, or dissolution. A company also has to disclose information if it signs a loan agreement or issues bonds, which is worth 30 percent or more of its equity; if it changes the Chairperson of the Board of Directors, or more than one-third of the members of the Board of Directors, or its Director (General Director); if a share split occurs, if it issues bonus shares or shares for paying dividends, which is worth more than 10 percent of the equity and if it applies for de-listing. Finally, the disclosure obligation concerns the suspicion of involvement in criminal acts, like violation of tax laws, of directors, supervisors, managers or the chief accountant.

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3 daily with two order-matching sessions at 9h20 am and 10h30 am. At the STC securities  
4 transactions are executed through a fully-computerised trading system, the Automatic Order-  
5 Matching and Put-Through Trading System. The system performs the order-matching process  
6 according to price-then-time priority, without human intervention. After securities brokerage  
7 companies electronically send buy or sell orders from their offices to the STC's mainframe  
8 computer, the system automatically executes an order-queuing process and arranges the  
9 orders according to a price-then-time priority. This procedure means that orders are first  
10 grouped by price, with the best price (highest price for buying and lowest price for selling)  
11 taking precedence. Then, within each price group, orders are arranged according to time. The  
12 trading price of a given stock is determined at a specified time (currently at 9h20 am and  
13 10h30 am daily) and at the price that generates the greatest trading volumes of the stock. In  
14 case of having two or more price levels that create the same trading volumes, the price closest  
15 to the previous trading session's closing price is chosen as the trading price.  
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34 Put-through trading is a method for securities trading at the STC that allows brokers to  
35 deal directly with each other, either on behalf of their clients or for themselves. The dealing  
36 price is negotiated between the two brokers and hence the executed price may not be the same  
37 as that of securities traded in the market on that day. Following the conclusion of negotiations  
38 and trading, dealers are required to send details of the negotiation results to the STC's  
39 mainframe for recording purposes.  
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48 Foreign investors (institutions and individuals) can buy or sell shares at the STC  
49 through securities companies. However, their ownership in a listed firm is limited to 30  
50 percent of the firm's equity. Foreign investors who wish to participate in the STC are required  
51 to register through a licensed custodian who holds securities on behalf of foreign investors.  
52 Currently, three foreign banks (the Hong Kong and Shanghai Banking Corporation, Deutsche  
53 Bank AG and Standard Chartered Bank) are licensed by the SSC to provide custodian  
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services for foreign investors. Moreover, foreign securities business institutions are allowed to buy shares of Vietnamese securities firms and/or investment funds, or contribute capital to establish a joint-venture securities firm and/or investment fund with Vietnamese partners. However, the proportion of capital contributed by foreign partners in a joint venture is maximized at 49 percent of the firms' chartered capital.

**3. The performance of the Vietnamese stock market**

The Vietnamese stock market was launched on July 28, 2000 with just two firms listed, Refrigeration Electrical Engineering Joint Stock Company (REE), and Saigon Cable and Telecommunication Material Joint Stock Company (SACOM). The growth of the number of listed companies has been rather slow. At the end of 2000 still only five joint-stock companies were listed, to be joined by only five more in 2001. In 2002 10 more companies are listed. By the end of 2005, a total of 32 joint-stock companies have been given permission to float their shares on the STC (see Table 2). All of the listed firms (except North Kinh Do Food Joint-Stock Company and Kinh Do Corporation) are former state-owned enterprises (SOEs) that were previously restructured by equitisation, the Vietnamese version of privatisation (see, *e.g.*, Truong, Lanjouw and Lensink, 2006). Out of the listed firms 20 operate in the manufacturing sector, while the rest belongs to the trading and services sector.

Table 3 presents information on key indicators of the development of the STC over the period from the opening year (2000) through December 30, 2005. During this period market capitalisation has increased significantly and continuously, from VND 444,000 million (USD 28.20 million) at the first trading session (July 28, 2000) to VND 2,650,197 million (USD 168.32 million) at year-end 2002, and to VND 6,337,480 million (USD 396.06 million) on December 30, 2005. Moreover, the data in Table 3 reveal that the market capitalisation-to-

GDP ratio has been negligible although it rose year by year. It goes up to 0.55 percent in 2004 from 0.24 percent in 2000.

Trading at the market also is still rather thin. Trading value at the STC has been tiny; during the first year of trading the average daily trading value is only VND 1,385 million (USD 0.09 million). It rises significantly in 2001 to VND 6,128 million (USD 0.39 million). Specifically, daily trading extraordinarily peaks on June 11, 2001 at VND 30,459 million (USD 1.93 million). However, daily trading value remarkably declines in the two consecutive following years (2002 and 2003) before temporarily moving upwards in the first half of 2004 and, later, in the second half of 2005. The developments in daily trading value over the period from July 28, 2000 to December 30, 2005 are shown in Figure 1. Another indicator of the thinness of trading at the STC is the trading-value-to-GDP ratio. This ratio has been negligible, although it rose considerably in 2004, after a continuous decline over the period 2000-2003. Low market capitalisation and commensurately small trading volumes make the Vietnamese stock market the smallest in the Southeast Asian region.

During the year following the STC's opening, the prices of all listed shares moved-up daily. Consequently, VN-INDEX considerably and continuously rose, moving from the initial base level of 100 to the record level of 571.04 on June 25, 2001. The main reason to explain the steep ascent of stock prices is the existence of an acute imbalance between supply of and demand for shares<sup>5</sup>. Since then, however, despite the government's great efforts in creating commodities for the market by stimulating joint-stock companies to have their stocks listed at the STC, the market index fell substantially. In fact, VN-INDEX has slipped-down from the top of 571.04 to a bottom of 130.9 on October 24, 2003. After falling to the bottom,

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<sup>5</sup> As of June 25, 2001, only six joint-stock companies with a total capital of VND 360,044 million (USD 22.87 million) had their stocks listed at the STC.

VN-INDEX has recovered and remained fairly stable at a level above 200 since January 2004. As of December 30, 2005 VN-INDEX stood at 307.50 points. The time pattern of VN-INDEX over the period from the STC's opening date to December 30, 2005 is graphically shown in Figure 2.

#### 4. Data description

The data used in this study consist of weekly price series of the market index (VN-INDEX) and the five oldest stocks listed at the STC, to wit REE, SAM, HAP, TMS and LAF<sup>6</sup>. We also have applied the same methodology to daily data, but since the results were similar we have not presented them here to save space. VN-INDEX is a composite index calculated from prices of all common stocks traded at the STC. Specifically, it is a market-capitalisation-weighted price index which compares the current market value of all listed common shares to their value on the base date of July 28, 2000 when the first trading session took place.

The data used in our empirical tests refer to the period July 28, 2000 (the day of the first trading session of the stock exchange) to Dec. 31, 2004. They come from the Bank for Investment & Development of Vietnam Securities Co.'s website ([www.bsc.com.vn](http://www.bsc.com.vn)). A natural-logarithm transformation is performed on these data. To generate a time series of continuously compounded returns, weekly returns are computed as follows:

$$r_t = \log(p_t) - \log(p_{t-1}) = \log(p_t / p_{t-1})$$

where  $p_t$  and  $p_{t-1}$  are the stock prices at time  $t$  and  $t-1$ .

The weekly returns are calculated as the natural logarithm of the index and the stock prices from Wednesday's closing price minus the natural logarithm of the previous

<sup>6</sup> The full firm names corresponding to the abbreviated firm names are given in Table 2.

Wednesday's close. If the following Wednesday price is not available, then the Thursday price (or Tuesday if Thursday is not available) is used. If both Tuesday and Thursday prices are not available, the return for that week is reported as missing. The choice of Wednesday prices aims to avoid the effects of weekend trading and to minimise the number of holidays (Huber, 1997).

Descriptive statistics for the weekly returns of VN-INDEX and the individual stocks are presented in Table 4.

## 5 Methodology

According to Fama (1970) market efficiency implies that successive price changes of a stock are independently and identically distributed. Thus, past price movements or trends of a stock or a stock market cannot be used to predict their future movement. We use several tests to examine market efficiency in the weak form, which form focuses on the information conveyed by past prices. We first use parametric autocorrelation tests to examine whether the consecutive stocks returns are independent. However, the results of the Jarque-Bera test (presented in Table 4), indicate that stock returns are not normally distributed. Therefore we also use a non-parametric test to investigate market efficiency. More specifically, we use the runs test. Furthermore the variance-ratio test, proposed by Lo and MacKinlay (1988), is conducted to examine whether uncorrelated increments exist in the series, under the assumption of homoscedastic and heteroscedastic random walks.

### Autocorrelation tests

The first approach to detect whether stock returns show a random walk summarized here is the autocorrelation test. Autocorrelation measures the relationship between the current stock return and its value in the previous period. It is calculated as:

$$\rho_k = \frac{\sum_{t=1}^{N-k} (r_t - \bar{r})(r_{t+k} - \bar{r})}{\sum_{t=1}^N (r_t - \bar{r})^2}$$

where  $\rho_k$  is the serial correlation coefficient of stock returns of lag  $k$ ;  $N$  is the number of observations;  $r_t$  is the stock return over period  $t$ ;  $r_{t+k}$  is the stock return over period  $t+k$ ;  $\bar{r}$  is the sample mean of stock returns; and  $k$  is the lag of the period.

The autocorrelation test aims to determine whether the serial-correlation coefficients are significantly different from zero. Statistically, the hypothesis of weak-form efficiency should be rejected if stock returns (price changes) are serially correlated ( $\rho_k$  is significantly different from zero).

To test the joint hypothesis that all autocorrelations are simultaneously equal to zero, the Ljung–Box portmanteau statistic ( $Q$ ) is used. The Ljung–Box  $Q$ -statistics are given by:

$$Q_{LB} = N(N+2) \sum_{j=1}^k \frac{\rho_j^2}{N-j}$$

where  $\rho_j$  is the  $j^{\text{th}}$  autocorrelation and  $N$  is the number of observations. Under the null hypothesis of zero autocorrelation at the first  $k$  autocorrelations ( $\rho_1 = \rho_2 = \rho_3 = \dots = \rho_k = 0$ ), the  $Q$ -statistic is distributed as chi-squared with degrees of freedom equal to the number of autocorrelations ( $k$ ).

### Runs test

The runs test is a non-parametric test that is designed to examine whether or not an observed sequence is random. The test is based on the premise that if a series of data is random, the observed number of runs in the series should be close to the expected number of the runs. A run can be defined as a sequence of consecutive price changes with the same sign. Therefore, price changes of stocks can be categorized into three kinds of runs: an upward run (prices go

up), a downward run (prices go down) and a flat run (prices do not change). Under the null hypothesis of independence in share-price changes (share returns), the total expected number of runs ( $m$ ) can be estimated as:

$$m = \frac{\left\{ N(N+1) - \sum_{i=1}^3 n_i^2 \right\}}{N}$$

where  $N$  is the total number of observations (price changes or returns) and  $n_i$  is the number of price changes (returns) in each category ( $N = \sum_{i=1}^3 n_i$ ). For a large number of observations ( $N > 30$ ), the sampling distribution of  $m$  is approximately normal and the standard error of  $m$  ( $\sigma_m$ ) is given by:

$$\sigma_m = \left\{ \frac{\sum_{i=1}^3 n_i^2 \left[ \sum_{i=1}^3 n_i^2 + N(N+1) \right] - 2N \sum_{i=1}^3 n_i^3 - N^3}{N^2(N-1)} \right\}^{1/2}$$

The standard normal Z-statistic that can be used to test whether the actual number of runs is consistent with the hypothesis of independence is given by:

$$Z = \frac{R \pm 0.5 - m}{\sigma_m}$$

where  $R$  is the actual number of runs,  $m$  is the expected number of runs, and 0.5 is the continuity adjustment (Wallis and Roberts, 1956) in which the sign of the continuity adjustment is negative (- 0.5) if  $R \geq m$ , and positive otherwise. Since there is evidence of dependence among share returns when  $R$  is too small or too large, the test is a two-tailed one.

### Variance ratio test

The variance-ratio test, proposed by Lo and MacKinlay (1988), is demonstrated to be more reliable and at least as powerful as the unit-root test (Lo and MacKinlay, 1988; Liu and He,



1991). The test is based on the assumption that the variance of increments in the random-walk series is linear in the sample interval. Specifically, if a series follows a random-walk process, the variance of its  $q$ -differences would be  $q$  times the variance of its first differences.

$$\text{Var}(p_t - p_{t-q}) = q \text{Var}(p_t - p_{t-1})$$

where  $q$  is any positive integer. The variance ratio,  $\text{VR}(q)$ , is then determined as follows:

$$\text{VR}(q) = \frac{\frac{1}{q} \text{Var}(p_t - p_{t-q})}{\text{Var}(p_t - p_{t-1})} = \frac{\sigma^2(q)}{\sigma^2(1)}$$

For a sample size of  $nq + 1$  observations  $(p_0, p_1, \dots, p_{nq})$ , the formulas for computing  $\sigma^2(q)$  and  $\sigma^2(1)$  are given in the following equations:

$$\sigma^2(q) = \frac{\sum_{t=q}^{nq} (p_t - p_{t-q} - q\hat{\mu})^2}{h}$$

where

$$h = q(nq + 1 - q)(1 - \frac{q}{nq})$$

and

$$\hat{\mu} = \frac{1}{nq} \sum_{t=1}^{nq} (p_t - p_{t-1}) = \frac{1}{nq} (p_{nq} - p_0)$$

$$\sigma^2(1) = \frac{\sum_{t=1}^{nq} (p_t - p_{t-1} - \hat{\mu})^2}{(nq - 1)}$$

Under the assumption of homoscedastic and heteroscedastic increments, respectively, two standard normal test-statistics,  $Z(q)$  and  $Z^*(q)$ , developed by Lo and MacKinlay (1988), are calculated by equations (8.21) and (8.22) below:

$$Z(q) = \frac{VR(q) - 1}{[\phi(q)]^{1/2}} \approx N(0,1)$$

$$Z^*(q) = \frac{VR(q) - 1}{[\phi^*(q)]^{1/2}} \approx N(0,1)$$

where  $\phi(q)$  is the asymptotic variance of the variance ratio under the assumption of homoscedasticity, and  $\phi^*(q)$  is the asymptotic variance of the variance ratio under the assumption of heteroscedasticity:

$$\phi(q) = \frac{2(2q-1)(q-1)}{3q(nq)}$$

$$\phi^*(q) = \sum_{j=1}^{q-1} \left[ \frac{2(q-j)}{q} \right]^2 \hat{\delta}(j)$$

where  $\hat{\delta}(j)$  is the heteroscedasticity – consistent estimator, computed as follows:

$$\hat{\delta}(j) = \frac{\sum_{t=j+1}^{nq} (p_t - p_{t-1} - \hat{\mu})^2 (p_{t-j} - p_{t-j-1} - \hat{\mu})^2}{\left[ \sum_{t=1}^{nq} (p_t - p_{t-1} - \hat{\mu})^2 \right]^2}$$

### Estimating the true returns: correcting for thin trading

As mentioned above, the Vietnamese stock market is characterized by thin and infrequent trading. Many studies have pointed out that thin or infrequent trading can cause a serious bias regarding the results on market efficiency (see Cohen *et al.*, 1978; Lo and MacKinlay, 1990a; Stoll and Whaley, 1990; Miller *et al.*, 1994). The problem is that the absence of a price change between two moments may be interpreted as being caused by the absence of a price reaction to new information and consequently as a sign that the market is inefficient, whereas it may simply be caused by the absence of any trade due to trading taking place infrequently.

To deal with the problem of thin trading, the methodology proposed by Miller *et al.* (1994) is employed in this study. To remove the effect of thin trading the model basically suggests that a moving-average model which reflects the number of non-trading days should be estimated, after which returns are adjusted accordingly. However, due to difficulties in determining non-trading days, Miller *et al.* (1994) show that it is equivalent to achieve the non-trading adjustment by estimating an AR(1) model. Specifically, the model can be stated in the following equation:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \varepsilon_t$$

Then, using the residuals from the above equation, adjusted returns are computed as follows:

$$R_t^{Adj} = \frac{\varepsilon_t}{1 - \alpha_1}$$

where  $R_t^{Adj}$  is the adjusted return for thin trading at time  $t$ .

It is important to note here that the above model assumes the non-trading adjustment to be constant over time. The assumption may be correct for developed markets, but it is not likely to be the case for emerging markets (Antoniou *et al.*, 1997). Therefore, in this study the equation is recursively estimated on a yearly basis.

All tests are conducted with both observed and corrected data. The results of these tests are discussed in the following section.

## 6. Empirical findings

### Autocorrelation tests

To test the weak form of market efficiency for the Vietnamese stock market, first the autocorrelation tests with 12 lags are performed for weekly returns of the VN-Index and five individual stocks. The results of these tests are summarized in Tables 5 and 6.

The estimation results show that autocorrelation coefficients of the observed weekly index returns are significant with a positive sign at the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> lags. Additionally, based on the Q-statistics, the null hypothesis of absence of autocorrelation in the index returns for all lags selected is strongly rejected at the one percent significance level. Furthermore, results of the autocorrelation tests on observed weekly returns for the individual stocks show significant autocorrelation coefficients for each individual stock-returns series. Specifically, significant autocorrelation coefficients are found at the 1<sup>st</sup>, 2<sup>nd</sup>, and 4<sup>th</sup> lag for REE; at the 1<sup>st</sup>, 2<sup>nd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> lag for SAM; at the 1<sup>st</sup> and 2<sup>nd</sup> lag for HAP; at the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 7<sup>th</sup> lag for TMS; and at the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, and 5<sup>th</sup> lag for LAF. The Q-statistics fail to support the joint null hypothesis that all autocorrelation coefficients from lag 1 to 12 are equal to zero for the observed return series of all individual stocks.

The results of the autocorrelation tests for the corrected returns indicate that the random-walk hypothesis is still rejected for the market index and all selected individual stocks, except REE.

### Runs test

To investigate weak-form efficiency of the Vietnamese stock market, the non-parametric runs test is also used in this study. The runs test is considered more appropriate than the parametric autocorrelation test since the observed series do not follow a normal distribution. Results of

the runs tests for weekly returns of the index and the selected individual stocks are reported in Table 7. The results indicate that the null hypothesis of independence among stock returns is rejected for the market index and all selected individual stocks, except HAP. However, when corrected returns are used, the results of the runs test reveal that the null hypothesis cannot be rejected for HAP, but it is to be rejected for REE and LAF. For the remaining series the rejection of the null hypothesis is unchanged, but the extent is less pronounced as compared with the results for the observed weekly data.

**Variance ratio tests**

This study employs variance-ratio tests for both null hypotheses, namely the homoscedastic- and heteroscedastic-increments random walk. In addition, the variance ratio is calculated for intervals ( $q$ ) of 2, 4, 8, 16 and 32 observations. The results of the variance-ratio tests are reported in Tables 8 and 9.

The estimation results again confirm that the null hypothesis of random-walk behaviour under the assumption of homoscedasticity is strongly rejected for all series for all values of  $q$ . Indeed, all  $Z$ -statistics are greater than the conventional critical value (1.96 for the five percent level). In addition, the heteroscedasticity-consistent variance-ratio test provides consistent evidence that the null hypothesis of random- walk behaviour cannot be accepted for any of the observed weekly-return series. Specifically, a comparison the  $Z^*$ -statistic to the conventional critical value reveals that the random-walk hypothesis is rejected at  $q = 2, 4, 8$ , and 16 for TMS and REE, and at  $q = 2, 4$ , and 8 for VN-INDEX and LAF. In the case of HAP the evidence against the null hypothesis under the assumption of heteroscedasticity is weak because only two rejections ( $q=2$  and  $q=4$ ) are reported.

Furthermore, when corrected returns are employed, similar results are obtained from the tests. Specifically, the null hypothesis of random-walk behaviour under the assumption of homoscedasticity is strongly rejected for all series for all values of  $q$ , while under the assumption of heteroscedasticity the null hypothesis cannot be accepted for all series for some values of  $q$ . The rejection of the null hypothesis is less pronounced for VN-INDEX, REE, TMS and LAF, but more pronounced for SAM and HAP as compared to the results for the observed weekly returns.

## 7. Conclusions

This paper provides a detailed description of the stock market in Vietnam and also examines whether the Vietnamese stock market is weak-form efficient. The weak form of market efficiency for the market index and five selected individual stocks is tested by using weekly return data for the period from July 28, 2000 to December 31, 2004. We apply three tests: the autocorrelation test, the runs test and the variance-ratio test. To deal with the problem of thin or infrequent trading, which could seriously bias the results, the observed returns are corrected by using the methodology proposed by Miller *et al.* (1994). The results obtained from the autocorrelation tests indicate that the null hypothesis of random-walk behaviour is conclusively rejected for the market index and four out of five selected individual stocks, even in the case that the returns are corrected for thin trading. In addition, the runs test provides evidence to reject the random-walk hypothesis for observed weekly returns of the market index and all selected individual stocks (except for HAP). However, when corrected returns are used, the results given by the runs tests fail to reject the random-walk hypothesis for REE and LAF. The results of Lo and MacKinley's variance-ratio

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test under both homoscedasticity and heteroscedasticity assumptions for both observed and corrected returns fail to support the random-walk hypothesis for the market index and all selected individual stocks.

In summary the predominant outcome of this study is that the Vietnamese stock market is inefficient in the weak form, even in case corrections are made for the thin trading that characterizes the market.

For Peer Review

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Table 1: Securities companies in Vietnam

Name of company	Capital (VND bil.)	Ownership	Trading at the STC since	Estimated market share* in Jan 04 (%)
Bao Viet Securities Co.	43	100% owned by Bao Viet Insurance; a state-owned insurance company.	Jul. 28, 00	21.1
Bank for Investment & Development of Vietnam Securities Co.	100	100% owned by Bank for Investment & Development of Vietnam; a state-owned bank	Jul. 28, 00	12.4
Asia Commercial Bank Securities Co.	43	100% owned by Asia Commercial Bank, a joint stock bank	Jul. 28, 00	14.4
Thang Long Securities Co.	43	100% owned by Military Bank, a joint stock bank	Jul. 28, 00	5.4
First Securities Co.	43	Privately owned joint stock company	Jul. 28, 00	5.5
Saigon Securities Incorporation	20	Privately owned joint stock company	Jul. 28, 00	23.2
Industry Commerce Bank Securities Co.	55	100% owned by Industry Commerce Bank, a state-owned bank	Nov. 16, 00	7.5
Bank for Agriculture & Rural Development Securities Co.	100	100% owned by Bank for Agriculture & Rural Development, a state-owned bank	Nov. 05, 01	2.5
Vietcombank Securities Co.	60	100% owned by Bank for Foreign Trade of Vietnam; a state-owned bank	Jun. 21, 02	5.7
Mekong Securities Co.	6	Institutions: 30% Individuals: 70%	Apr. 02, 03	0.5
Ho Chi Minh Securities Co.	50	State: 28.8% Institutions: 57.2% Individuals: 14.0%	May 02, 03	1.7
Eastern Asia Bank Securities Co.	21	100% owned by Eastern Asia Commercial Joint Stock Bank	Sep. 15, 04	n/a
Hai Phong Securities Joint Stock Co.	21.75	State: 46% Others: 52%	Oct. 29, 03	n/a

Source: Dragon Capital Group's website, [www.dragoncapital.com](http://www.dragoncapital.com)

\* Market shares are calculated based on order-matching transactions.

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Table 2: Companies listed at the STC (as of Dec. 31, 2005)

No	Date of listing	Company	Code	Sector	Number of outstanding common shares	Share price at IPO (1,000 VND)	Share price at Dec. 31, 2005 (1,000 VND)
1	Jul. 28, 2000	Refrigeration Electrical Engineering Company	REE	Manufacturing	15,000,000	16.0	34.4
2	Jul. 28, 2000	Cable and Telecommunications Material Company	SAM	Manufacturing	12,000,000	17.0	47.0
3	Aug. 04, 2000	Hai Phong Paper Joint Stock Company	HAP	Manufacturing	2,008,000	16.0	22.8
4	Aug. 04, 2000	Transimex Joint Stock Company	TMS	Transportation	3,300,000	14.0	43.4
5	Dec. 15, 2000	Long An Food Processing Export Company	LAF	Manufacturing	1,930,082	17.0	20.3
6	Jul. 12, 2001	Saigon Hotel Corporation	SGH	Hotel	1,766,300	25.2	18.0
7	Oct. 18, 2001	Halong Canned Food Joint Stock Company	CAN	Manufacturing	3,500,000	27.1	17.2
8	Nov. 26, 2001	Da Nang Plastics Joint Stock Company	DPC	Manufacturing	1,587,280	35.0	12.2
9	Dec. 17, 2001	Bien Hoa Confectionery Company	BBC	Manufacturing	5,600,000	27.0	21.9
10	Dec. 26, 2001	Saigon Beverages Joint Stock Company	TRI	Manufacturing	3,790,300	29.0	28.0
11	Jan. 02, 2002	Binh Thanh Import-Export Production & Trade Joint Stock Company	GIL	Trade	1,700,000	38.0	32.0
12	Jan. 17, 2002	Binh Trieu Construction and Engineering Joint Stock Company	BTC	Manufacturing	1,261,345	21.9	8.1
13	Apr. 11, 2002	Bim Son Packaging Company	BPC	Manufacturing	3,800,000	25.0	16.2
14	Apr. 18, 2002	Chau Thoi Concrete Corporation	BT6	Construction	5,882,690	23.9	31.0
15	Apr. 22, 2002	General Forwarding & Agency Corporation	GMD	Transportation	20,000,000	42.5	69.5

Table 2 continued

16	May 02, 2002	An Giang Fisheries Import & Export Joint Stock Company	AGF	Manufacturing	4,179,130	30.0	42.0
17	May 09, 2002	Savimex Corporation	SAV	Manufacturing	4,500,000	25.0	31.0
18	Aug. 29, 2002	Seafood Joint Stock Company No. 4	TS4	Manufacturing	1,500,000	16.0	26.0
19	Aug. 19, 2002	Khanh Hoi Import Export Joint Stock Company	KHA	Trade	3,350,000	21.5	21.3
20	Dec. 18, 2002	Hanoi P&T Construction and Installation Joint Stock Company	HAS	Construction	1,200,000	21.5	32.8
21	Feb. 12, 2003	VTC Telecommunications Joint Stock Company	VTC	Manufacturing	1,797,740	21.0	32.9
22	Nov. 04, 2003	Petroleum Mechanical Joint Stock Company	PMS	Manufacturing	3,200,000	14.5	14.4
23	Mar. 15, 2004	Bach Tuyet Cotton Corporation	BBT	Manufacturing	6,840,000	21.6	11.0
24	Apr. 14, 2004	Hoa An Joint Stock Company	DHA	Manufacturing	3,500,000	38.5	43.0
25	Sep. 21, 2004	Saigon Fuel Joint Stock Company	SFC	Trade	1,700,000	22.8	28.5
26	Dec. 12, 2005	Kinh Do Corporation	KDC	Manufacturing	25,000,000	59.0	54.0
27	Mar. 1, 2005	Southern Seed Joint-Stock Corporation	SSC	Agriculture	6,000,000	30.8	44.0
28	Mar. 21, 2005	HaNoi Maritime Holding Company	MHC	Transportation	6,705,640	19.0	23.3
29	Jul. 11, 2005	Phuong Nam Culture Joint-Stock Corporation	PNC	Trade	2,000,000	16.0	16.6
30	Jul. 20, 2005	Thien Nam Trading Import Export Corporation	TNA	Trade	1,300,000	30.0	31.0
31	Dec. 12, 2005	Kinh Do Corporation	KDC	Manufacturing	25,000,000	59.0	54.0
32	Dec. 16, 2005	Nhi-Hiep Brike-Tile Joint Stock Company	NHC	Manufacturing	1,336,061	23,000	24.5

Source: The State Securities Commission's website ([www.ssc.gov.vn](http://www.ssc.gov.vn))

*Table 3: Key development indicators for the STC over the period 2000-2005*

Indicators	2000	2001	2002	2003	2004	2005
Number of listed companies	5	10	20	23	26	32
Market capitalisation (bil. VND)	1,048.76	1,661.10	2,650.20	2,514.29	3,945.31	6,337.48
Market capitalisation on GDP (%)	0.24	0.34	0.49	0.42	0.55	na
Yearly trading value (bil. VND)	91.40	925.38	762.77	422.50	1,692.99	2,435.64
Trading value on GDP (%)	0.02	0.19	0.14	0.07	0.24	na
Average daily trading value (bil. VND)	1.39	6.13	3.23	1.71	6.80	9.82
VN-INDEX	206.83	235.40	183.33	166.94	239.29	307.50
Percentage change in VN-INDEX (%)	-	+ 13.8	- 22.1	- 8.9	+ 43.3	+ 28.5

Source: Own calculation on the basis of data obtained from the Bank for Investment & Development of Vietnam Securities Company's website, [www.bsc.com.vn](http://www.bsc.com.vn).

Notes: All figures refer to the end of the year indicated.

na: not available

*Table 4: Descriptive statistics for VN-INDEX and individual stock returns*

	VN-INDEX	REE	SAM	HAP	TMS	LAF
Observations	225	225	225	224	224	205
Mean	0.0016	0.0007	0.0014	0.0007	0.0016	0.0013
Median	0.0003	0.0000	0.0011	0.0011	0.0000	0.0000
Maximum	0.0840	0.0834	0.0853	0.1718	0.2850	0.1567
Minimum	-0.0894	-0.1774	-0.1768	-0.2553	-0.3010	-0.1467
Std. Dev.	0.0189	0.0259	0.0240	0.0365	0.0376	0.0283
Skewness	-0.4	-1.5	-2.0	-3.1	-0.97	-0.1
Kurtosis	8.0	13.6	17.8	26.4	36.97	11.0
Jarque-Bera	239.9 <sup>a</sup>	1,129.9 <sup>a</sup>	2,201.8 <sup>a</sup>	5485.9 <sup>a</sup>	10,808.3 <sup>a</sup>	543.5 <sup>a</sup>

<sup>a</sup>: Indicates that the null hypothesis of normality is rejected at the 1% significant level

Table 5: Results of autocorrelation tests for the observed weekly-return data

Lag	VN-INDEX		REE		SAM		HAP		TMS		LAF	
	AC	Q-stat	AC	Q-stat	AC	Q-stat	AC	Q-stat	AC	Q-stat	AC	Q-stat
1	0.328 <sup>a</sup>	24.554 <sup>a</sup>	0.266 <sup>a</sup>	16.090 <sup>a</sup>	0.175 <sup>a</sup>	6.986 <sup>a</sup>	-0.188 <sup>a</sup>	8.016 <sup>a</sup>	0.200 <sup>a</sup>	9.106 <sup>a</sup>	0.164 <sup>b</sup>	5.588 <sup>b</sup>
2	0.250 <sup>a</sup>	38.905 <sup>a</sup>	0.177 <sup>a</sup>	23.271 <sup>a</sup>	0.144 <sup>b</sup>	11.712 <sup>a</sup>	0.310 <sup>a</sup>	29.971 <sup>a</sup>	0.246 <sup>a</sup>	22.922 <sup>a</sup>	0.219 <sup>a</sup>	15.633 <sup>a</sup>
3	0.155 <sup>b</sup>	44.434 <sup>a</sup>	0.120	26.589 <sup>a</sup>	0.040	12.085 <sup>a</sup>	-0.066	30.968 <sup>a</sup>	0.178 <sup>a</sup>	30.196 <sup>a</sup>	0.215 <sup>a</sup>	25.379 <sup>a</sup>
4	0.206 <sup>a</sup>	54.280 <sup>a</sup>	0.201 <sup>a</sup>	35.946 <sup>a</sup>	0.172 <sup>a</sup>	18.921 <sup>a</sup>	0.063	31.883 <sup>a</sup>	0.151 <sup>b</sup>	35.418 <sup>a</sup>	0.097	27.372 <sup>a</sup>
5	0.239 <sup>a</sup>	67.540 <sup>a</sup>	0.118	39.169 <sup>a</sup>	0.170 <sup>b</sup>	25.666 <sup>a</sup>	0.090	33.762 <sup>a</sup>	0.232 <sup>a</sup>	47.884 <sup>a</sup>	0.226 <sup>a</sup>	38.241 <sup>a</sup>
6	0.075	68.838 <sup>a</sup>	0.077	40.550 <sup>a</sup>	-0.039	26.029 <sup>a</sup>	0.015	33.817 <sup>a</sup>	0.088	49.692 <sup>a</sup>	0.128	41.709 <sup>a</sup>
7	0.089	70.685 <sup>a</sup>	0.066	41.577 <sup>a</sup>	0.064	26.993 <sup>a</sup>	-0.002	33.818 <sup>a</sup>	0.136 <sup>b</sup>	54.008 <sup>a</sup>	0.009	41.727 <sup>a</sup>
8	-0.013	70.725 <sup>a</sup>	0.096	43.739 <sup>a</sup>	-0.031	27.214 <sup>a</sup>	0.008	33.833 <sup>a</sup>	0.078	55.431 <sup>a</sup>	-0.083	43.212 <sup>a</sup>
9	0.098	72.993 <sup>a</sup>	-0.034	44.020 <sup>a</sup>	0.105	29.817 <sup>a</sup>	0.068	34.936 <sup>a</sup>	0.059	56.246 <sup>a</sup>	0.094	45.123 <sup>a</sup>
10	-0.077	74.391 <sup>a</sup>	0.016	44.082 <sup>a</sup>	-0.091	31.773 <sup>a</sup>	-0.002	34.937 <sup>a</sup>	0.027	56.419 <sup>a</sup>	-0.097	47.192 <sup>a</sup>
11	0.069	75.516 <sup>a</sup>	-0.007	44.093 <sup>a</sup>	0.018	31.850 <sup>a</sup>	0.061	35.809 <sup>a</sup>	0.051	57.037 <sup>a</sup>	0.022	47.297 <sup>a</sup>
12	0.031	75.741 <sup>a</sup>	0.006	44.103 <sup>a</sup>	-0.007	31.861 <sup>a</sup>	0.048	36.369 <sup>a</sup>	0.047	57.561 <sup>a</sup>	0.021	47.393 <sup>a</sup>

<sup>a</sup>, <sup>b</sup>: Significant at the 1% and 5% levels, respectively.

Table 6: Results of autocorrelation tests for the corrected weekly-return data

Lag	VN-INDEX		REE		SAM		HAP		TMS		LAF	
	AC	Q-stat	AC	Q-stat	AC	Q-stat	AC	Q-stat	AC	Q-stat	AC	Q-stat
<b>1</b>	-0.055	0.687	-0.033	0.244	-0.005	0.005	-0.010	0.022	-0.079	1.406	-0.046	0.448
<b>2</b>	0.143 <sup>b</sup>	5.377	0.055	0.939	0.069	1.095	0.238 <sup>a</sup>	12.863 <sup>a</sup>	0.165 <sup>b</sup>	7.578 <sup>b</sup>	0.181 <sup>a</sup>	7.270 <sup>b</sup>
<b>3</b>	0.017	5.442	0.047	1.455	-0.022	1.209	0.025	13.006 <sup>a</sup>	0.058	8.345 <sup>b</sup>	0.165 <sup>b</sup>	12.927 <sup>a</sup>
<b>4</b>	0.099	7.707	0.100	3.761	0.162 <sup>b</sup>	7.213	-0.011	13.035 <sup>b</sup>	-0.008	8.360	-0.004	12.930 <sup>b</sup>
<b>5</b>	0.178 <sup>a</sup>	15.016 <sup>a</sup>	0.081	5.265	0.162 <sup>b</sup>	13.305 <sup>b</sup>	0.089	14.846 <sup>b</sup>	0.243 <sup>a</sup>	21.917 <sup>a</sup>	0.211 <sup>a</sup>	22.340 <sup>a</sup>
<b>6</b>	-0.040	15.386 <sup>b</sup>	0.008	5.280	-0.107	15.944 <sup>b</sup>	0.016	14.904 <sup>b</sup>	-0.011	21.945 <sup>a</sup>	0.062	23.152 <sup>a</sup>
<b>7</b>	0.093	17.410 <sup>b</sup>	0.051	5.881	0.056	16.662 <sup>b</sup>	-0.053	15.569 <sup>b</sup>	0.147 <sup>b</sup>	26.992 <sup>a</sup>	0.026	23.300 <sup>a</sup>
<b>8</b>	-0.104	19.948 <sup>b</sup>	0.006	5.889	-0.053	17.320 <sup>b</sup>	-0.006	15.576 <sup>b</sup>	-0.080	28.496 <sup>a</sup>	-0.171 <sup>b</sup>	29.549 <sup>a</sup>
<b>9</b>	0.144 <sup>b</sup>	24.800 <sup>a</sup>	0.001	5.889	0.139 <sup>b</sup>	21.887 <sup>a</sup>	0.051	16.175	0.110	31.308 <sup>a</sup>	0.131	33.260 <sup>a</sup>
<b>10</b>	-0.170 <sup>b</sup>	31.648 <sup>a</sup>	-0.044	6.345	-0.128	25.769 <sup>a</sup>	-0.018	16.249	-0.098	33.548 <sup>a</sup>	-0.139 <sup>b</sup>	37.422 <sup>a</sup>
<b>11</b>	0.107	34.366 <sup>a</sup>	0.018	6.425	0.024	25.911 <sup>a</sup>	0.069	17.392	0.075	34.865 <sup>a</sup>	0.024	37.546 <sup>a</sup>
<b>12</b>	-0.055	34.438 <sup>a</sup>	0.003	6.427	-0.000	25.911 <sup>b</sup>	0.045	17.872	-0.123	38.488 <sup>a</sup>	0.045	37.986 <sup>a</sup>

<sup>a</sup>, <sup>b</sup>: Significant at the 1% and 5% levels, respectively.



Table 7: Results of the runs test for VN-Index and selected individual stocks

Variables	Obs. (N)	Actual runs (R)	Expected runs (m)	Z-statistic
<i>Observed weekly returns</i>				
VN-INDEX	225	81	113	-4.27 <sup>a</sup>
REE	225	111	135	-3.35 <sup>a</sup>
SAM	225	100	125	-3.52 <sup>a</sup>
HAP	224	123	131	-1.09
TMS	224	103	129	-3.67 <sup>a</sup>
LAF	205	105	124	-2.76 <sup>a</sup>
<i>Corrected weekly returns</i>				
VN-INDEX	224	95	113	-2.34 <sup>b</sup>
REE	224	103	113	-1.24
SAM	224	92	113	-2.71 <sup>a</sup>
HAP	223	86	104	-2.50 <sup>b</sup>
TMS	223	92	112	-2.59 <sup>a</sup>
LAF	204	93	103	-1.33

<sup>a</sup>, <sup>b</sup>: Significant at the 1% and 5% levels, respectively.

Table 8: Variance-ratio test results for the observed weekly-return data

Variables	Number nq of base observations	Number q of base observations aggregated to form variance ratio				
		2	4	8	16	32
<b>VN-INDEX</b>	224					
VR(q)		0.56	0.30	0.20	0.10	0.06
Z(q)		-6.56 <sup>a</sup>	-5.59 <sup>a</sup>	-4.05 <sup>a</sup>	-3.05 <sup>a</sup>	-2.21 <sup>b</sup>
Z <sup>*</sup> (q)		-2.92 <sup>a</sup>	-2.80 <sup>a</sup>	-2.19 <sup>b</sup>	-1.71	-1.39
<b>REE</b>	224					
VR(q)		0.58	0.31	0.19	0.11	0.06
Z(q)		-6.23 <sup>a</sup>	-5.49 <sup>a</sup>	-4.09 <sup>a</sup>	-3.01 <sup>a</sup>	-2.20 <sup>b</sup>
Z <sup>*</sup> (q)		-3.11 <sup>a</sup>	-3.16 <sup>a</sup>	-2.68 <sup>a</sup>	-2.14 <sup>b</sup>	-1.76
<b>SAM</b>	224					
VR(q)		0.52	0.25	0.17	0.08	0.05
Z(q)		-7.14 <sup>a</sup>	-5.97 <sup>a</sup>	-4.18 <sup>a</sup>	-3.11 <sup>a</sup>	-2.22 <sup>b</sup>
Z <sup>*</sup> (q)		-3.26 <sup>a</sup>	-2.89 <sup>a</sup>	-2.16 <sup>b</sup>	-1.71	-1.38
<b>HAP</b>	223					
VR(q)		0.36	0.18	0.10	0.06	0.03
Z(q)		-9.59 <sup>a</sup>	-6.57 <sup>a</sup>	-4.55 <sup>a</sup>	-3.19 <sup>a</sup>	-2.26 <sup>b</sup>
Z <sup>*</sup> (q)		-2.63 <sup>a</sup>	-2.17 <sup>b</sup>	-1.95	-1.80	-1.60
<b>TMS</b>	223					
VR(q)		0.52	0.31	0.18	0.10	0.06
Z(q)		-7.20 <sup>a</sup>	-5.46 <sup>a</sup>	-4.11 <sup>a</sup>	-3.05 <sup>a</sup>	-2.20 <sup>b</sup>
Z <sup>*</sup> (q)		-3.91 <sup>a</sup>	-3.32 <sup>b</sup>	-2.75 <sup>a</sup>	-2.22 <sup>b</sup>	-1.79
<b>LAF</b>	204					
VR(q)		0.47	0.27	0.17	0.08	0.05
Z(q)		-7.55 <sup>a</sup>	-5.55 <sup>a</sup>	-4.01 <sup>a</sup>	-2.98 <sup>a</sup>	-2.14 <sup>b</sup>
Z <sup>*</sup> (q)		-3.80 <sup>a</sup>	-3.05 <sup>a</sup>	-2.29 <sup>b</sup>	-1.83	-1.51

<sup>a</sup>, <sup>b</sup>: Significant at the 1% and 5% levels, respectively.

Table 9: Variance-ratio test results for the corrected weekly-return data

Variables	Number nq of base observations	Number q of base observations aggregated to form variance ratio				
		2	4	8	16	32
<b>VN-INDEX</b>	223					
VR(q)		0.41	0.22	0.14	0.06	0.04
Z(q)		-8.82 <sup>a</sup>	-6.24 <sup>a</sup>	-4.35 <sup>a</sup>	-3.18 <sup>a</sup>	-2.25 <sup>b</sup>
Z <sup>*</sup> (q)		-3.33 <sup>a</sup>	-2.69 <sup>a</sup>	-2.08 <sup>b</sup>	-1.63	-1.32
<b>REE</b>	223					
VR(q)		0.45	0.23	0.13	0.07	0.04
Z(q)		-8.14 <sup>a</sup>	-6.17 <sup>a</sup>	-4.38 <sup>a</sup>	-3.14 <sup>a</sup>	-2.25 <sup>b</sup>
Z <sup>*</sup> (q)		-3.11 <sup>a</sup>	-2.75 <sup>a</sup>	-2.24 <sup>b</sup>	-1.80	-1.52
<b>SAM</b>	223					
VR(q)		0.46	0.21	0.14	0.07	0.04
Z(q)		-7.99 <sup>a</sup>	-6.33 <sup>a</sup>	-4.34 <sup>a</sup>	-3.16 <sup>a</sup>	-2.24 <sup>b</sup>
Z <sup>*</sup> (q)		3.68 <sup>a</sup>	3.14 <sup>a</sup>	2.35 <sup>b</sup>	1.85	1.49
<b>HAP</b>	222					
VR(q)		0.45	0.20	0.11	0.06	0.04
Z(q)		-8.18 <sup>a</sup>	-6.35 <sup>a</sup>	-4.46 <sup>a</sup>	-3.16 <sup>a</sup>	-2.25 <sup>b</sup>
Z <sup>*</sup> (q)		-3.21 <sup>a</sup>	-2.96 <sup>a</sup>	-2.51 <sup>b</sup>	-2.15 <sup>b</sup>	-1.81
<b>TMS</b>	222					
VR(q)		0.38	0.24	0.13	0.06	0.04
Z(q)		-9.21 <sup>a</sup>	-6.03 <sup>a</sup>	-4.38 <sup>a</sup>	-3.18 <sup>a</sup>	-2.24 <sup>b</sup>
Z <sup>*</sup> (q)		-3.05 <sup>a</sup>	-2.34 <sup>b</sup>	-1.96 <sup>b</sup>	-1.60	-1.30
<b>LAF</b>	203					
VR(q)		0.39	0.24	0.15	0.07	0.04
Z(q)		-8.62 <sup>a</sup>	-5.76 <sup>a</sup>	-4.11 <sup>a</sup>	-3.02 <sup>a</sup>	-2.15 <sup>b</sup>
Z <sup>*</sup> (q)		-3.34 <sup>a</sup>	-2.48 <sup>b</sup>	-1.85	-1.48	-1.24

<sup>a</sup>, <sup>b</sup>: Significant at the 1% and 5% levels, respectively.

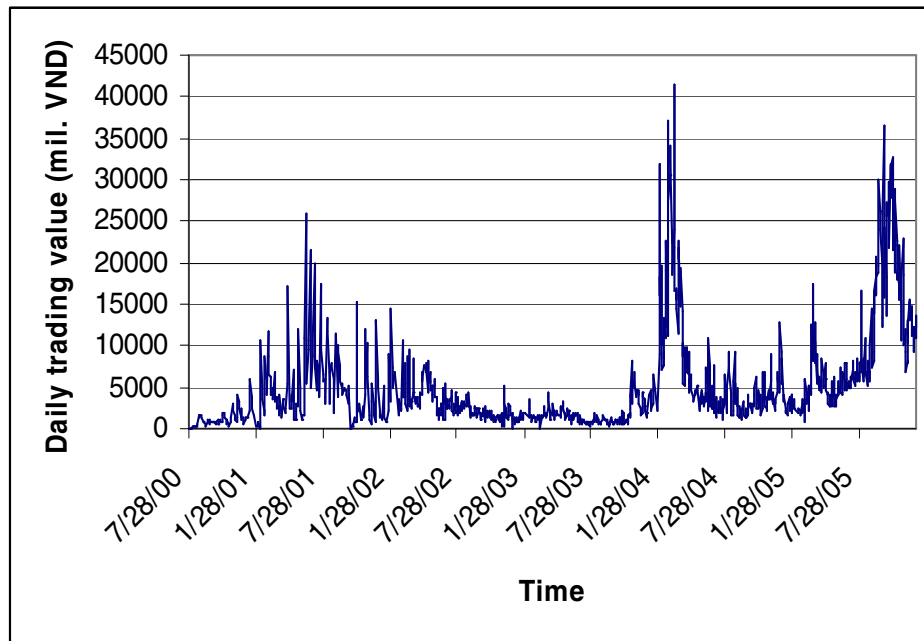


Figure 1: Daily trading value over the period July 28, 2000 – December 30, 2005

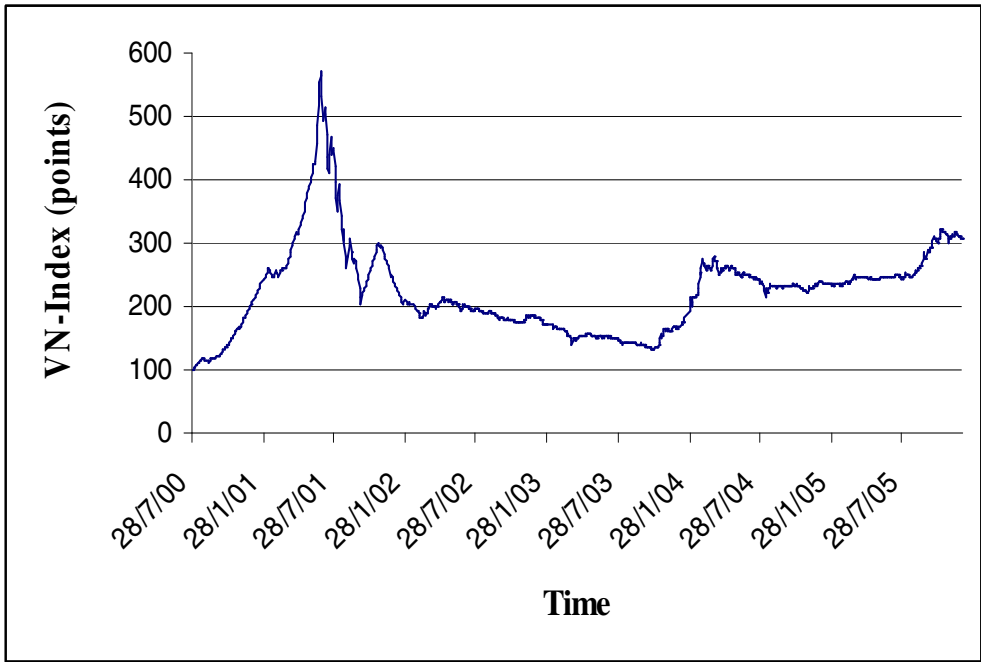


Figure 2: VN-INDEX changes over the period July 28, 2000 to December 30, 2005